

## FINAL REPORT for Temporary Permit for Diversion and Use Water (TP21375)

The Yolo County Flood Control and Water Conservation District (District) filed Application T032756 to appropriate water by temporary permit on December 13, 2016, pursuant to Water Code section 1425 et seq. The District proposed to divert up to 72,000 acre-feet (AF), at a maximum rate of 600 cubic feet per second (cfs), from Cache Creek for groundwater recharge (underground storage) in the Yolo and Colusa subbasins for later irrigation use. The District received Temporary Permit 21375 (TP21375) from the State Water Resources Control Board on January 11, 2017. Under TP21375, the District diverted approximately 6,210 AF of water from Cache Creek at the Capay Diversion Dam (Dam). The 2017 January and February storm events impacted Yolo County and damaged some of the District's canal system and infrastructure. Due to the severity of canal erosion and sediment deposition, diversions were not started as early as desired. Diversions occurred March 16-22, and March 28 – April 30, 2017; and infiltration occurred within the District's existing 160-mile canal system. Water stored underground was the first set volume of groundwater extracted by overlying well-owners for irrigation use within the District's service area during the 2017 irrigation season, which started May 1, 2017. During April 1-30, 2017 of the diversion period, 121 AF was diverted under the District's Statement of Diversion and Use S000608 for irrigation purposes.

Permit Terms 010500, 0109999, 0000204, and 0360899 of TP21375 necessitate this Final Report (Report). As required by Term 010500, this Report includes the total quantity of water diverted under the temporary permit and any other amounts diverted from the point of diversion under other bases of right during the reporting period, the quantity of water applied to beneficial use, and a map of the location used for infiltration. As required by Term 0109999, this Report includes records of the daily quantity and maximum rate of diversion under the temporary permit and other amounts diverted under other bases of right during the reporting period. Additionally, as required by Terms 0000204 and 0360899, this Report includes the corresponding daily mean flow as recorded at the United States Geological Survey (USGS) Gauge 11452500 on Cache Creek near Yolo (Yolo Gauge), the USGS Gauge 11452800 at the Cache Creek Settling Basin Overflow Weir, the USGS Gauge 11453000 at the Yolo Bypass, and the Department of Water Resources (DWR) Fremont Weir Gauge.

In compliance with Term 0000204, no water was diverted under the temporary permit when mean daily average flows at the USGS Yolo Gauge were below 50 cfs. In compliance with Term 0360899, no water was diverted in times that Cache Creek was considered to have hydraulic continuity with the Yolo Bypass absent diversion unless the mean daily average flows at the USGS Yolo Gauge were above 101 cfs. Hydraulic continuity between Cache Creek and the Yolo Bypass was determined on a daily basis, based on whether or not the Cache Creek Settling Basin Overflow Weir was overtopping. The Delta was In Excess from December 11, 2016 through the entire diversion period.

## **MEASUREMENT AND ACCOUNTING OF WATER DIVERTED TO UNDERGROUND STORAGE AND EXTRACTED FOR BENEFICIAL USE**

On January 12, 2017, the District submitted a plan to the State Water Resources Control Board for measurement and accounting of water diverted to underground storage and extracted for beneficial use, and provided current photographs of the device or method installed with certification that it was properly installed, calibrated, and operating as designed.

### **Flow Diversion Measurement**

Diversions by the District were monitored at the Capay Diversion Dam using the acoustic doppler velocity devices installed at the head of the West Adams and Winters Canals. The District's supervisory control and data acquisition (SCADA) system was used to monitor and report water diversions on a regular basis. Diversions at the Dam occurred in real-time and decisions were made based on the bypass requirements of the temporary permit, existing water levels in the canals, and forecasted storm data. The additional 121 AF that was diverted during the diversion period for irrigation purposes was tracked using the District's STORM water account and management system, which relies on flow measurements at each farm-delivery gate.

### **Tracking of Diversions**

The District spatially tracked the conveyance of diverted stormwater throughout the canal system and utilized the District's existing groundwater monitoring wells and SCADA system to monitor the groundwater recharge during and after diversions. The summary of the daily stormwater flow diversions is shown in Table 1, along with the daily gauge readings as required by the permit terms. As discussed in Application T032756, Cache Creek flows at the Yolo Gauge were found to be insignificant in comparison to the flows at the Yolo Bypass Gauge. Similarly, the flows observed to be overtopping the Settling Basin Overflow Weir are considered inconsequential relative to flows in the Yolo Bypass.

Figure 1 illustrates the District's 160 miles of canals, which were used as stormwater infiltration basins to recharge the groundwater basin. During the diversion period, no agricultural fields were used for infiltration as the stormwater flows remained in the canals.

The summary of the daily irrigation diversions recorded under the District's S000608 water right is provided in Table 2.

### **Determination of Hydraulic Continuity Absent Diversions**

Flows in Cache Creek have a large seasonal and annual variability: flood flows in the basin are primarily caused by runoff during high intensity rainstorms during winter and spring, and generally, it takes significant storm flows to get flows down to the Cache Creek Settling Basin Weir. Additionally, there are several operational variabilities that must be considered when investigating the nature of flows at the Cache Creek Settling Basin; these include the existing capacity of and water levels in the Settling Basin, how the contiguous gates are controlled by Conaway, and whether or not the nearby storm drain is causing backwater into the Settling Basin flow gauges.

Determining hydraulic continuity between Cache Creek and the Yolo Bypass can be accomplished many ways; in lieu of a complex hydraulic routing we used conservative assumptions, a simplified storage routing concept, and available average gauge data. The hydraulic continuity between Cache Creek and the Yolo Bypass was determined on a daily basis by monitoring USGS's overflow weir gauge at the Cache Creek Settling Basin Weir. The USGS rating curve for Gauge 11452800 calculates the flow going over the weir as a dependent variable of the stage at the weir. Flows overtop the Settling Basin Overflow Weir when the stage is greater than 34.37 feet<sup>1</sup>.

During the days when flow was found to be overtopping the weir it was determined that Cache Creek was hydraulically connected to the Yolo Bypass, and would be absent the diversion. Once storm flows decreased and flows were no longer determined to be overtopping the Settling Basin Weir, an absent diversion stage was determined using the storage routing concept defined as follows:

$$I - Q = \frac{\Delta S}{\Delta t},$$

where

$I$  = Inflow

$Q$  = Outflow

$\Delta S$  = Change in storage

$\Delta t$  = Change in time

This concept assumes that the Settling Basin is leveed on all sides, the Basin area would not change, and that no attenuation would occur from the Dam and the Settling Basin. Since the Settling Basin area is 3,600 acres<sup>2</sup>, the change in storage over time can be a simple analysis of the daily volume of water that would have traveled through the Settling Basin (250 AF<sup>3</sup>) absent the diversion:

$$I - Q = \frac{\Delta S}{\Delta t} = \frac{250 \frac{\text{AF}}{\text{day}}}{3,600 \text{ acres}} = 0.07 \text{ feet/day},$$

On April 5, 2017, the stage at the Settling Basin was 34.35 feet, which potentially could have been 34.40 feet absent the diversion; however, Gauge 11452800 at the Settling Basin Overflow Weir recorded a flow of 2 cfs. After April 5, as the stage and flows temporarily diminished in Cache Creek and, in effect flows attenuated, the additional 125 cfs would not have caused the flows to overtop the Settling Basin Weir. Again, on April 26, 2017, the stage at the Settling Basin was 34.21 feet, which potentially could have been 34.28 feet absent the diversion, which would not have caused overtopping at the Weir as the flows dropped and attenuated.

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<sup>1</sup> The 11452800 Cache Creek Overflow Weir from Settling Basin Near Woodland Gauge Rating Curve can be found at the following link: <http://waterwatch.usgs.gov/?m=mkrc&sno=11452800>

<sup>2</sup> USACE's General Design Conference: Cache Creek Basin Informational Pamphlet. <http://s3-us-west-2.amazonaws.com/uclidc-nuxeo-ref-media/f43cd72f-881c-467d-aa68-610c9add5a4c>

<sup>3</sup> Conservative estimate as flows were technically below 250 AF: April 5 (196 AF), April 6 (202 AF), April 7 (169 AF), April 26 (197 AF), April 27 (164 AF), April 28 (247 AF), and April 29 and April 30 (244 AF) (see Table 1).

As mentioned above, during the entire diversion period the Delta was in Excess Conditions.

### Groundwater Recharge and Extraction

Groundwater recharge occurred through the District's unlined canals. The District's real-time monitoring wells were used to monitor the groundwater use over time. The District's groundwater monitoring network is shown in Figure 2.

After April 30, 2017, the end of the diversion period, the District continued to monitor the groundwater levels within the District's service area. Using average depth to groundwater data for monitoring wells #1 through 9, it is estimated that the 6,210 acre-feet of banked groundwater was extracted by May 4, 2017. The average depth to groundwater data was recorded through the District's SCADA system and the average levels for April 30, 2017 were compared to May 4, 2017, as shown in Figure 3 and Table 3. A specific yield of 6.5%<sup>4</sup> was used to estimate groundwater extractions over the 100,000-acre service area. With an average decrease in groundwater levels of 1.23 feet multiplied by the specific yield and service area acreage, approximately 8,000 acre-feet of groundwater was extracted by May 4, 2017.

### CONCLUSION

During the diversion period, the water was diverted and used without injury to any lawful water user, and without unreasonable effect on fish, wildlife, and other instream resources. No claims of impact were brought forward by downstream water users and the attitude throughout the service area was considered positive and encouraging. The temporary diversion of water from the Dam optimized the beneficial use of water within the Cache Creek watershed by strengthening the District's conjunctive water use program and implementing sustainable groundwater management practices in Yolo County. The stormwater diversions were discussed at many water resources management meetings throughout the County and throughout the Sacramento Valley to impress upon others the benefit of available conjunctive use opportunities. The District continues to discuss the conjunctive use benefits in the Yolo Subbasin's Sustainable Groundwater Management Act meetings, and highlights stormwater capture for groundwater recharge as a principal management action in the future Yolo Subbasin Groundwater Sustainability Plan.

Despite the heavy storms and damaged infrastructure, the 2017 stormwater diversions for groundwater recharge project was considered successful and was distinguished as aligning with the Governor's California Water Action Plan; Action Items 2, 5, 6, 8, and 9, specifically.

For long-term water supply benefits, the District is interested in obtaining a long-term permit that would ensure sustainable groundwater management by increasing conjunctive management opportunities in Yolo County. In the interim and in an anticipation of the continuation of Governor's Executive Order B-36-15 to facilitate the accelerated approvals for temporary permits for stormwater diversions, the

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<sup>4</sup> Groundwater storage in Yolo County – Bulletin 118. "Specific yields were calculated, based on well log information, for three separate depth intervals within six study areas, and ranged from 6.5% and 9.7%." [http://www.water.ca.gov/pubs/groundwater/bulletin\\_118/basindescriptions/5-21.67.pdf](http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-21.67.pdf)

District plans to request another temporary permit. The District will apply lessons learned and advance the District's conjunctive use program by expanding the acreage of groundwater recharge and opportunities for collaboration.

**TABLE 1. Daily Gauge and Storm Water Diversion Data for Groundwater Storage**

Date	11452500 Yolo Gauge (cfs; daily avg.)	11452800 CC Settling Basin Overflow Gauge (cfs; daily avg.)	11452800 CC Settling Basin Gauge Overflow (ft.; daily avg. stage)	11453000 Yolo Bypass Gauge (cfs; daily avg.)	Fremont Weir Stage (feet)	Settling Basin Overflow Weir Overtopping Absent Diversion (Y/N)	Average Diverted Flow to Groundwater Recharge (cfs)	Maximum Rate of Diversion to Groundwater Recharge (cfs)	Total Diversions to Groundwater Recharge (AF)
3/16/2017	2,660	3,630	> 34.37	4,530	29.92	Y	25	49	50
3/17/2017	2,660	No Data Avail.	> 34.37	4,350	29.26	Y	50	51	99
3/18/2017	2,560	No Data Avail.	> 34.37	4,190	29.51	Y	50	51	99
3/19/2017	2,490	No Data Avail.	> 34.37	4,080	31.57	Y	49	50	98
3/20/2017	2,330	No Data Avail.	> 34.37	5,090	32.88	Y	49	50	97
3/21/2017	2,450	No Data Avail.	> 34.37	12,600	33.16	Y	48	49	95
3/22/2017	2,520	3,400	> 34.37	20,900	33.43	Y	24	47	47
3/28/2017	1,500	1,020	> 34.37	25,200	33.62	Y	25	49	49
3/29/2017	1,460	832	> 34.37	18,100	33.26	Y	50	50	99
3/30/2017	1,420	861	> 34.37	9,420	32.86	Y	50	50	100
3/31/2017	1,010	658	> 34.37	4,280	32.32	Y	87	87	171
4/1/2017	870	249	> 34.37	2,800	31.55	Y	95	98	189
4/2/2017	678	191	> 34.37	2,400	30.60	Y	103	103	204
4/3/2017	596	78	> 34.37	2,130	29.46	Y	99	99	197
4/4/2017	491	24	> 34.37	1,870	28.32	Y	67	106	132
4/5/2017	409	2	< 34.37	1,670	27.42	Y	99	102	196
4/6/2017	402	0	< 34.37	1,540	26.91	N	102	102	202
4/7/2017	1,110	0	< 34.37	1,740	26.95	N	85	87	169
4/8/2017	1,530	364	> 34.37	2,170	29.44	Y	74	81	147
4/9/2017	1,610	676	> 34.37	3,060	32.57	Y	79	79	157
4/10/2017	1,290	591	> 34.37	8,050	33.14	Y	76	76	150
4/11/2017	1,230	442	> 34.37	7,770	32.98	Y	73	73	144
4/12/2017	1,220	406	> 34.37	5,270	32.79	Y	72	72	142
4/13/2017	1,360	427	> 34.37	4,000	32.64	Y	71	73	141
4/14/2017	1,350	533	> 34.37	3,960	32.86	Y	70	70	139
4/15/2017	1,270	457	> 34.37	7,840	33.21	Y	69	71	136

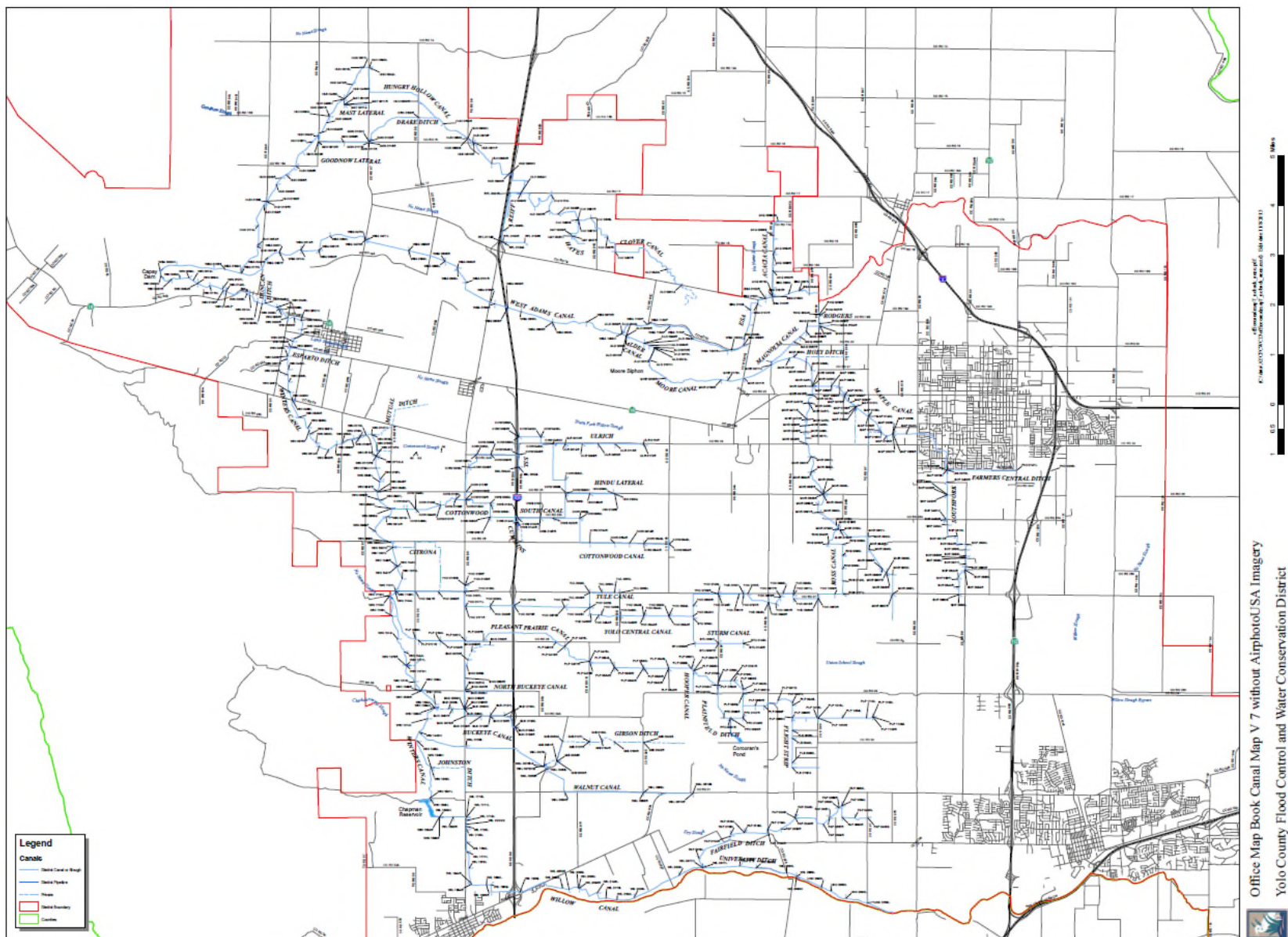
**TABLE 1. Daily Gauge and Storm Water Diversion Data for Groundwater Storage (Continued)**

Date	11452500 Yolo Gauge (cfs; daily avg.)	11452800 CC Settling Basin Gauge (cfs; daily avg.)	11452800 CC Settling Basin Gauge (ft.; stage)	11453000 Yolo Bypass Gauge (cfs; daily avg.)	Fremont Weir Stage (feet)	Settling Basin Overflow Weir Overtopping Absent Diversion (Y/N)	Average Diverted Flow to Groundwater Recharge (cfs)	Maximum Rate of Diversion to Groundwater Recharge (cfs)	Total Diversions to Groundwater Recharge (AF)
4/16/2017	1,260	444	> 34.37	17,200	33.43	Y	69	71	137
4/17/2017	1,440	516	> 34.37	20,300	33.49	Y	71	72	140
4/18/2017	1,440	595	> 34.37	21,400	33.54	Y	72	72	143
4/19/2017	1,410	582	> 34.37	23,700	33.65	Y	79	96	156
4/20/2017	1,140	505	> 34.37	26,300	33.76	Y	89	95	176
4/21/2017	1,100	358	> 34.37	27,500	33.80	Y	93	95	183
4/22/2017	1,080	306	> 34.37	26,800	33.77	Y	93	95	185
4/23/2017	772	225	> 34.37	26,100	33.74	Y	93	93	184
4/24/2017	592	78	> 34.37	25,400	33.72	Y	91	91	180
4/25/2017	461	20	> 34.37	25,100	33.71	Y	93	93	185
4/26/2017	362	0	< 34.37	24,500	33.69	N	100	165	197
4/27/2017	304	0	< 34.37	24,300	33.67	N	83	129	164
4/28/2017	197	0	< 34.37	24,200	33.67	N	125	125	247
4/29/2017	227	0	< 34.37	23,200	33.61	N	123	125	244
4/30/2017	322	0	< 34.37	20,400	33.44	N	123	124	244
<b>ESTIMATED TOTAL DIVERSIONS through April 30, 2017</b>									<b>6,210</b>

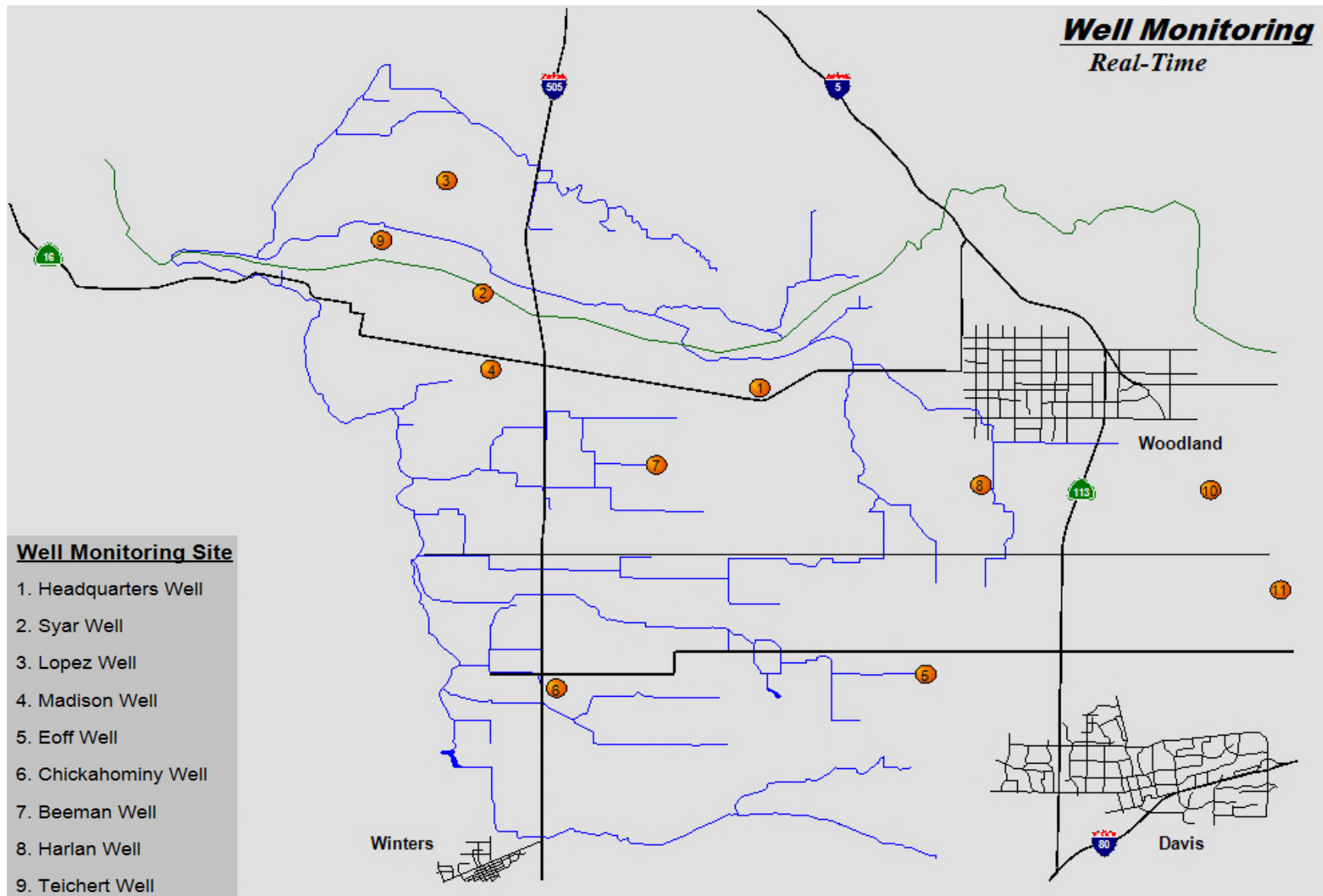
**TABLE 2. Irrigation Diversions Recorded under District Statement of Use S000608**

Date	Total Diversions for Irrigation Purposes (AF)
3/16/2017	0.00
3/17/2017	0.00
3/18/2017	0.00
3/19/2017	0.00
3/20/2017	0.00
3/21/2017	0.00
3/22/2017	0.00
3/28/2017	0.00
3/29/2017	0.00
3/30/2017	0.00
3/31/2017	0.00
4/1/2017	0.00
4/2/2017	0.00
4/3/2017	0.00
4/4/2017	0.00
4/5/2017	2.93
4/6/2017	17.53
4/7/2017	0.00
4/8/2017	0.00
4/9/2017	0.00
4/10/2017	0.00
4/11/2017	0.00
4/12/2017	0.00
4/13/2017	0.00
4/14/2017	0.00
4/15/2017	0.33
4/16/2017	0.00
4/17/2017	0.00
4/18/2017	0.00
4/19/2017	0.00
4/20/2017	0.08
4/21/2017	0.79
4/22/2017	0.17
4/23/2017	0.49
4/24/2017	8.44
4/25/2017	0.17
4/26/2017	2.32
4/27/2017	38.60
4/28/2017	39.79
4/29/2017	7.28
4/30/2017	1.78
<b>TOTAL IRRIGATION DIVERSIONS = 120.7 AF</b>	

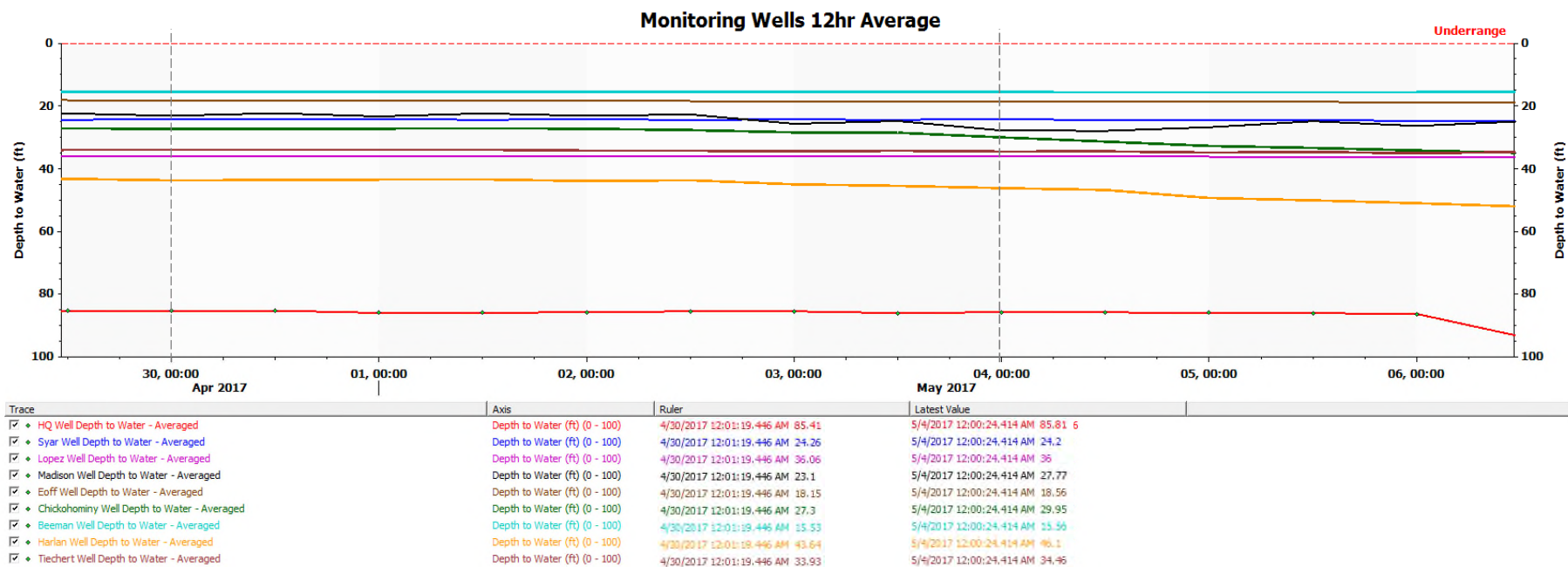




**Figure 1. District Canal System**



**Figure 2. Location of District Groundwater Monitoring Wells**



**Figure 3. Average Groundwater Levels in District Monitoring Wells (April 30 – May 6, 2017)**

**Table 3. Groundwater Extraction Estimates**

Well Monitoring Site	April 30, 2017 Depth to Water (feet)	May 4, 2017 Depth to Water (feet)	Delta (feet)
1. Headquarters Well	85.41	85.81	-0.40
2. Syar Well	24.26	24.20	0.06
3. Lopez Well	36.06	36.00	0.06
4. Madison Well	23.10	27.77	-4.67
5. Eoff Well	18.15	18.56	-0.41
6. Chickahominy Well	27.30	29.95	-2.65
7. Beeman Well	15.53	15.56	-0.03
8. Harlan Well	43.64	46.10	-2.46
9. Teichert Well	33.93	36.46	-0.53

Delta Statistics
N = 9
Stdev = 1.66
Avg = -1.23
Min = -0.03
Max = -4.67